PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 :		(11) International Publication Number: WO 88/ 01096
H01F 23/00	A1	(43) International Publication Date: 11 February 1988 (11.02.88)

(21) International Application Number: PCT/GB87/00554

(22) International Filing Date: 3 August 1987 (03.08.87)

(31) Priority Application Number: 8619316

(32) Priority Date: 7 August 1986 (07.08.86)

(33) Priority Country: GB

(71) Applicant *(for all designated States except US)*: CONTROLOGY PRODUCTS LIMITED [GB/GB]; 18 Colvilles Place, East Kilbride, Glasgow G75 0TF (GB).

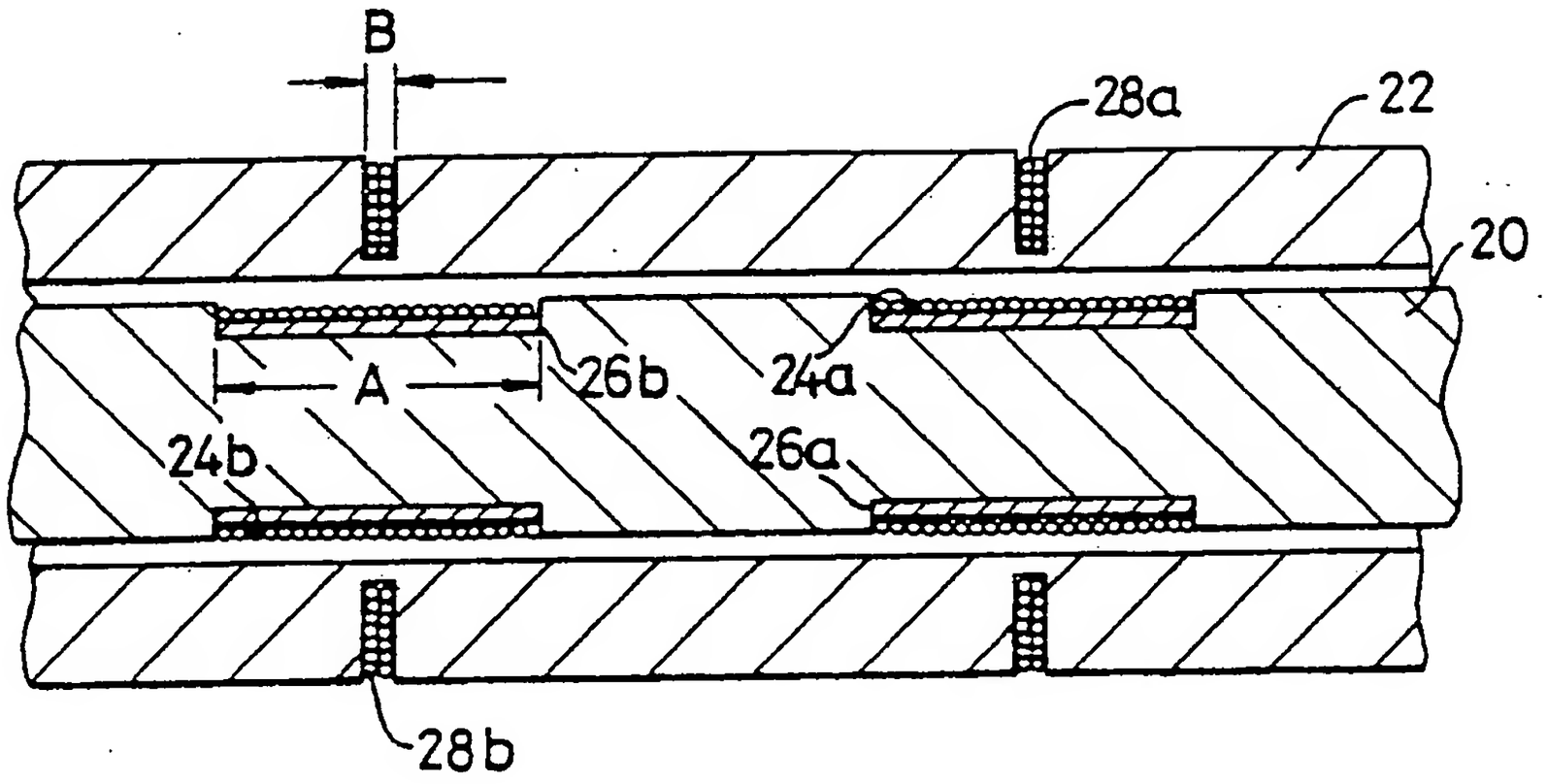
(72) Inventors; and
(75) Inventors/Applicants *(for US only)* : HALE, John, Christopher [GB/GB]; 11 Le Froy lane, East Kilbride, Glasgow G75 8BJ (GB). HALE, Christopher, Charles, Harold [GB/GB]; 17 Erskine, Beverage Court, Dunfermline, Fife KY11 3AJ (GB).

(74) Agent: FITZPATRICKS; 4 West Regent Street, Glasgow G2 1RS (GB).

(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), LU (European patent), NL (European patent), SE (European patent), US.

Published
With international search report.

(54) Title: ROTARY SIGNAL COUPLER



(57) Abstract

Signals are coupled between a shaft (20) and a housing (22) which rotate relative to each other by means of a primary coil (24) inductively coupled with a secondary coil (26). The primary coil (24) has a relatively large extent (A) and the secondary coil has a much smaller extent (B) and is positioned at the centre of the primary (24). Suitably $A/B \geqslant 6$.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	ML	Mali
AU	Australia	GA	Gabon	MR	Mauritania
BB	Barbados	GB	United Kingdom	MW	Malawi
BE	Belgium	HU	Hungary	NL	Netherlands
BG	Bulgaria	IT	Italy	NO	Norway
BJ	Benin	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic			SE	Sweden
CG	Congo	KR	Republic of Korea	SN	Senegal
CH	Switzerland	LI	Liechtenstein	SU	Soviet Union
CM	Cameroon	LK	Sri Lanka	TD	Chad
DE	Germany, Federal Republic of	LU	Luxembourg	TG	Togo
DK	Denmark	MC	Monaco	US	United States of America
FI	Finland	MG	Madagascar		

Rotary Signal Coupler

This invention relates to a coupling for transmitting electrical signals between first and second members which undergo relative rotation.

The invention is particularly, but not exclusively, of relevance to the inspection of long hollow cylindrical objects, such as drill collars for oil boreholes. A drill collar typically has a length of 10 m and an internal bore of about 78 mm; this makes internal inspection for cracks and the like difficult.

In our EP-A-0 033802 there is disclosed an electromagnetic inspection apparatus using a probe with twin windings. This apparatus is suitable for detecting defects of interest in drill collars and the like, but it is necessary to scan the probe over the internal surface. One way of doing this would be to draw through the bore on which the probe is rotatably mounted, so that spiral scan is performed. However, it is necessary to couple the signals from the rotating probe to a non-rotating instrument including a bridge circuit. Since the parameter of interest is a small out-of-balance quantity, it is very easy for this to be swamped by noise in the coupling. It has also been found that the signal of interest can be swamped by spurious signals arising from non-uniformity of rotational and translational movement.

Accordingly, an object of the present invention is to provide a coupling of the kind stated and which provides low noise and a high immunity to non-uniform movement.

The invention provides a rotary coupling for transferring an electrical signal between first and second members arranged to undergo relative rotation, comprising a primary winding on the first member, and a secondary winding on the second member adjacent the primary winding for inductive coupling therewith,

the primary winding having a given linear extent and the secondary winding being positioned within a minor part of and spaced from the ends of said linear extent.

Preferably there are two primary and two secondary windings, both pairs being as specified in the preceding paragraph, for coupling two signals.

In a preferred form, the first member is a shaft and the second member a surrounding sleeve. The primary winding is a single-layer coil of length A on the shaft surface, and the secondary a multi-layer coil of length B on the sleeve adjacent the centre of the primary. Suitably $A/B \geq 6$.

Preferably, the face of the primary winding away from the secondary winding is covered with a ferrite material.

Embodiments of the invention will now be described, by way of example, with reference to the drawings, in which:-

Fig 1 is a perspective view of an inspection apparatus incorporating the invention;

Fig 2 is a diagrammatic cross-section of a coupling embodying the invention for use in the apparatus of Fig 1;

Fig 3 is a similar view of an alternative embodiment of the coupling; and

Fig 4 is a side view, partly in cross-section, of a further embodiment.

The inspection apparatus shown in Fig 1 comprises a cylindrical body 10 dimensioned to be pulled through the bore of a tubular member by a cable 12. The body 10 has spring-biased wheels 14 for engagement with the bore. A probe 16, suitably of the type described in EP-A-0033802, is mounted in a holder 18 which is rotatable with respect to the body 10, to produce a helical scanning pattern.

Referring to Fig 2, the probe and holder are attached to a shaft 20 rotatable within a sleeve 22. The two windings of the probe 16 are connected each to a respective primary winding 24a, 24b, which are single-layer windings formed over ferrite layers 26a, 26b in circumferential grooves in the outer surface of the shaft 20.

Each primary winding 24a, 24b is inductively coupled with a respective secondary winding 28a, 28b, these being multi-layer

windings formed in narrow slots in the sleeve 22.

In accordance with the invention, the linear extent A of the primary windings 24 is considerably larger than the linear extent B of the secondary windings. The purpose is to position the secondary winding in an area of uniform flux from its primary, and to avoid coupling in the end zone of the primary where flux concentration occurs.

This minimises noise induced by axial movement between the shaft and the sleeve, or lack of concentricity in the rotational movement. It has been found that $A/B \geq 6$ is suitable, and that (while the coupling efficiency is poor) induced noise is very low.

The alternative embodiment shown in Fig 3 operates in a similar manner and like parts are denoted by like references. In this case, however, the primary windings 24 are disc-shaped in a transversely extending flange 30 and are coupled with secondary windings 28 in an annular housing 32. Bearings 34 journal the shaft 20 for rotation in the housing 32.

Fig 4 illustrates the invention applied to the inspection of a narrow-bore tube 40 having a bore too small to accept the rotary coupling. A probe 16 is mounted on the end of a rod 42 for rotation and translation within the tube 40. Bearing means indicated at 44 are provided for locating the probe 16 within the tube 40. The rod 42 is rotated by a drive assembly 46 embodying the coupling described above and located outside the tube 40. It will be understood that the rod 42 houses conductors connecting the probe 16 to the inductive coupling.

Preferably, the rod 42 is sectional, the sections being provided with mechanical screw or bayonet connectors and mating electrical contacts. This permits long tubing to be inspected with the drive assembly requiring axial movement only by the section length.

CLAIMS:

1. A rotary coupling for transferring an electrical signal between first and second members arranged to undergo relative rotation, comprising a primary winding on the first member, and a secondary winding on the second member adjacent the primary winding for inductive coupling therewith, the primary winding having a given linear extent and the secondary winding being positioned within a minor part of and spaced from the ends of said linear extent.

2. A rotary coupling having two primary and two secondary windings, arranged in pairs of a primary and a secondary winding, each pair being in accordance with claim 1, for coupling two signals.

3. A rotary coupling according to claim 1, in which the first member is a shaft and the second member is a sleeve.

4. A rotary coupling according to claim 3, in which the primary winding is a single-layer coil of length A on the shaft surface, and the secondary a multi-layer coil of length B on the sleeve adjacent the centre of the primary.

5. A rotary coupling according to claim 4, in which A:B is equal to or greater than 6.

6. A rotary coupling according to claim 1, in which the face of the primary winding away from the secondary winding is covered with a ferrite material.

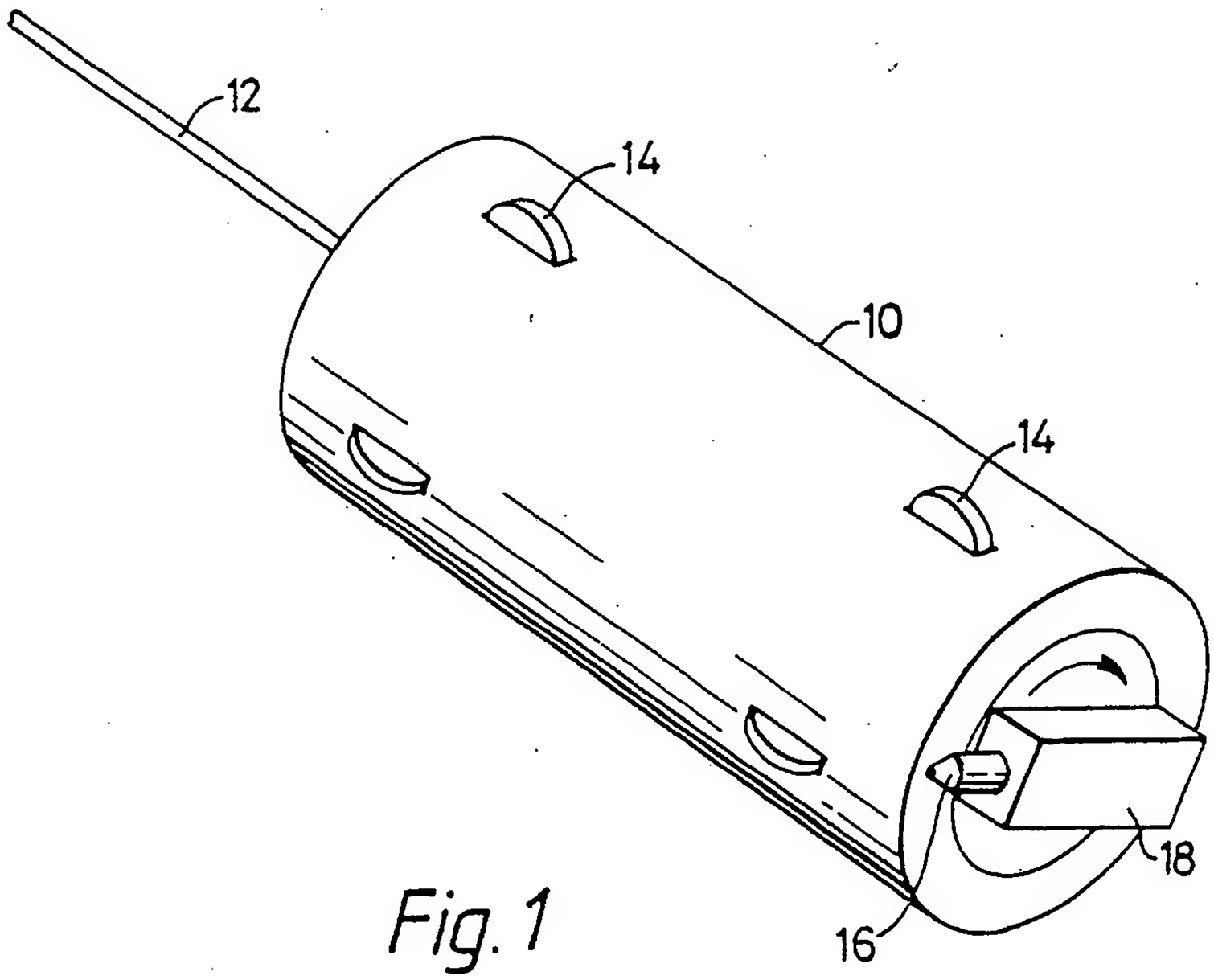


Fig. 1

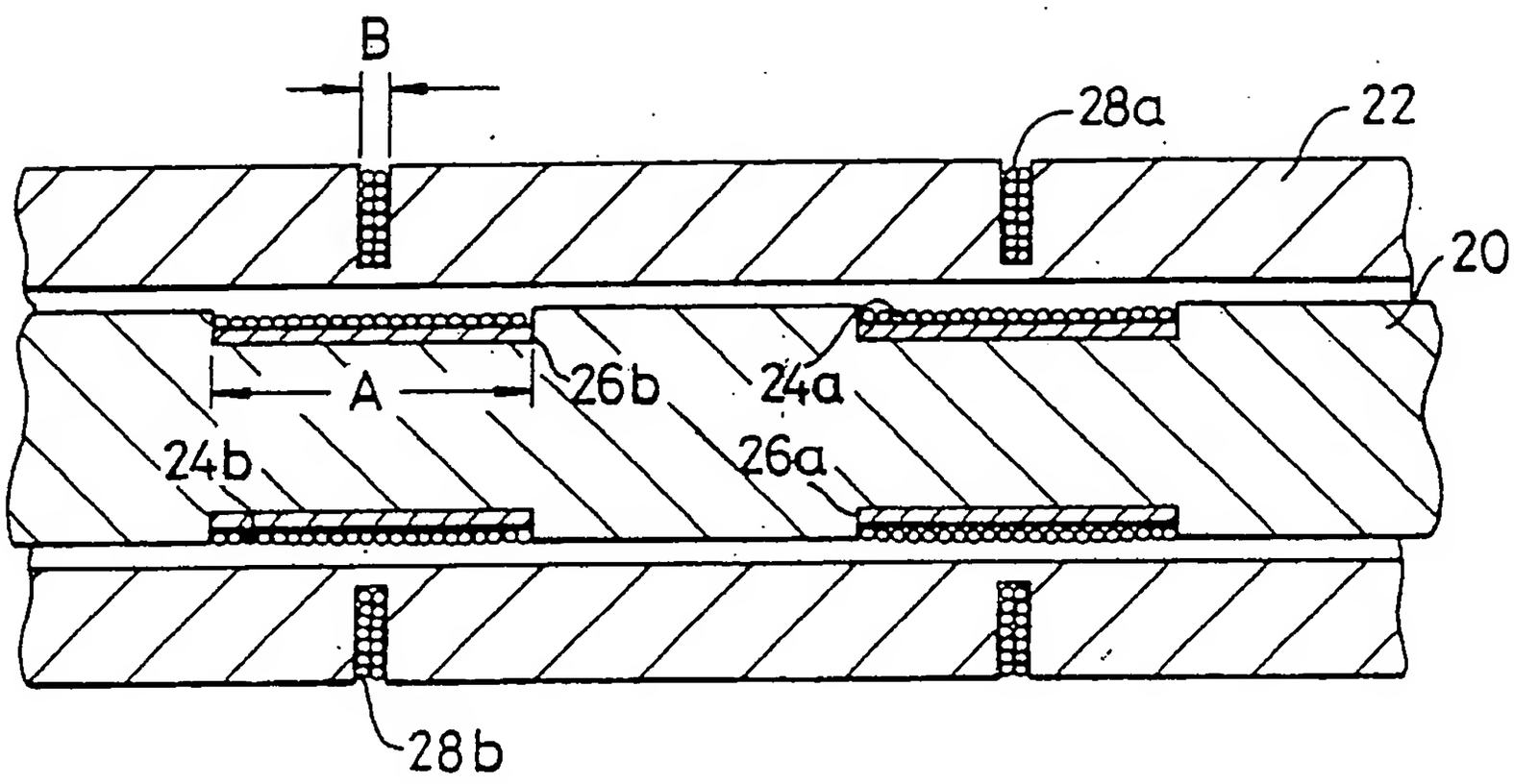

B
28a
22
20
A
26b
24a
24b
26a
28b

Fig. 2

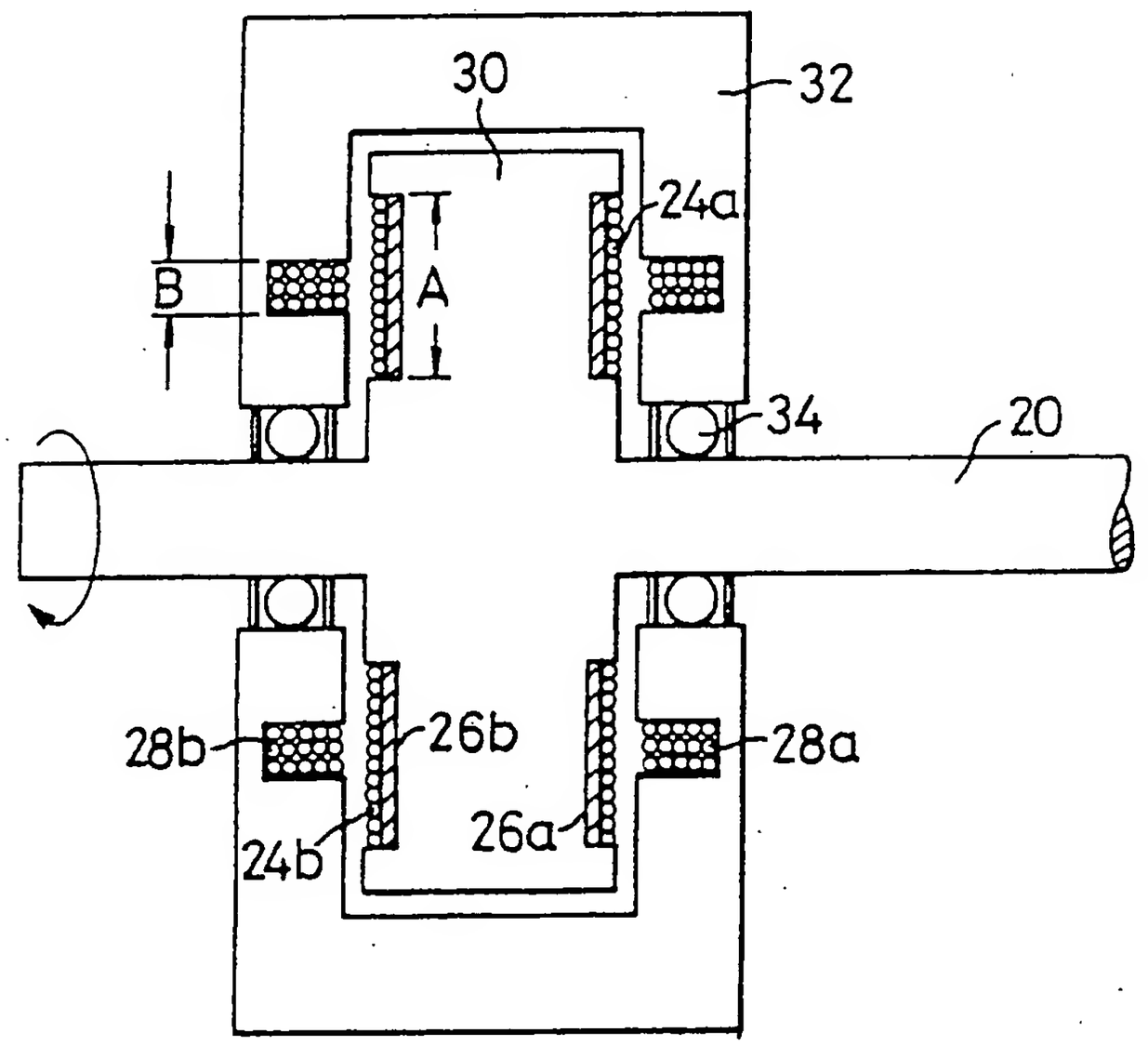

30
32
24a
B
A
34
20
28b
26b
28a
26a
24b

Fig. 3

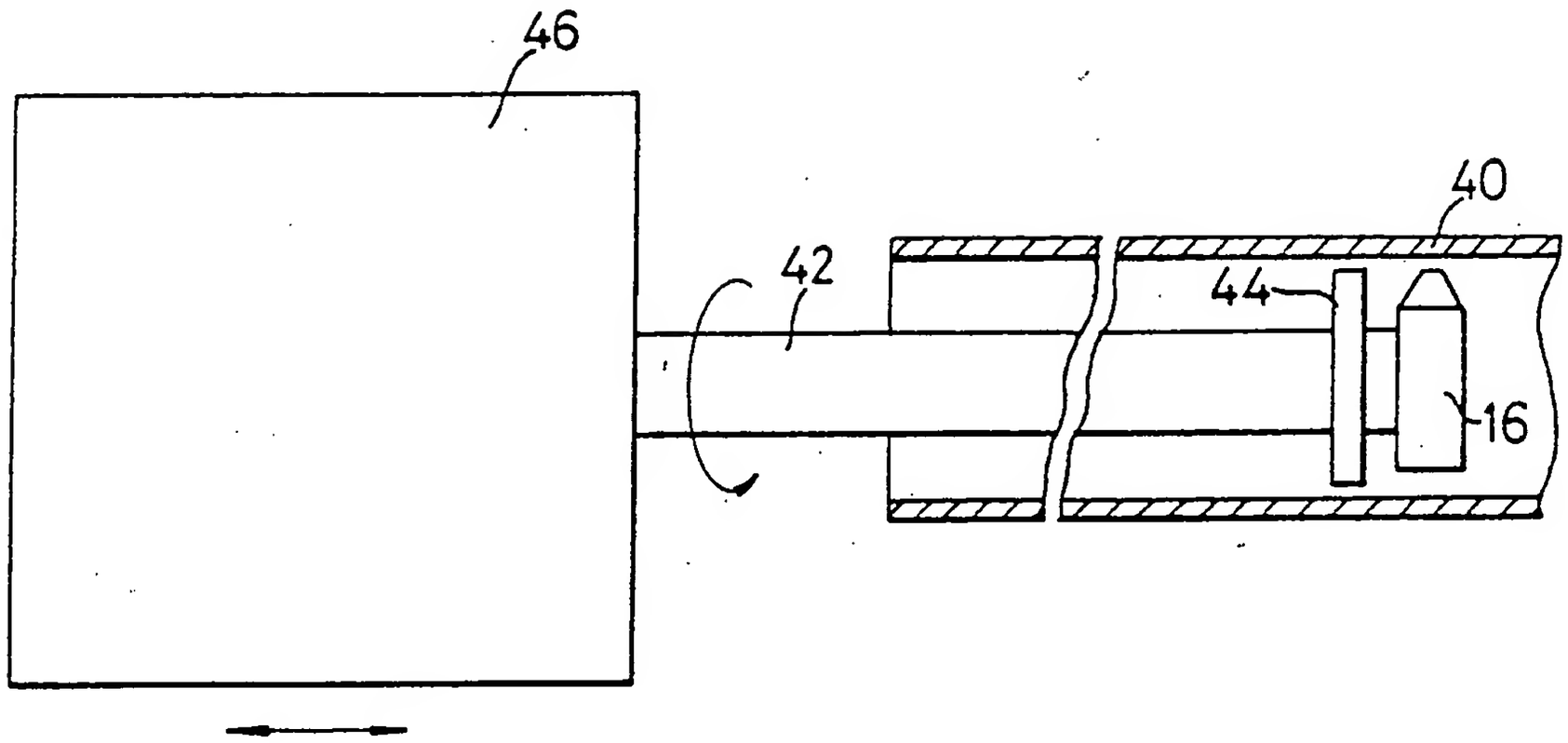


Fig. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 87/00554

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: H 01 F 23/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	H 01 F; G 01 N

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with Indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	GB, A, 2058475 (WESTINGHOUSE) 8 April 1981 see page 2, lines 88-111; figures 3,4	1,3
A	DE, A, 1920890 (VOGELER) 12 November 1970 see page 3, lines 19-29; figure 2	1,3
A	Patent Abstracts of Japan, vol. 10, no. 168(E-411)(2224), 14 June 1986 see the whole document & JP, A, 6120308 (PIONEER K.K.) 29 January 1986	2
A	US, A, 3519969 (HOFFMAN) 7 July 1970	

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
21st October 1987	24 NOV 1987
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	M. VAN MOL

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 87/00554 (SA 18141)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 05/11/87

The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
GB-A- 2058475	08/04/81	FR-A,B	2464544	06/03/81
		JP-A-	56036112	09/04/81
		DE-A-	3032320	10/09/81
		US-A-	4303902	01/12/81
		CA-A-	1122666	27/04/82
		GB-A,B	2100592	06/01/83
		FR-A,B	2507884	24/12/82
		SE-A-	8103840	19/12/82
		JP-A-	58001430	06/01/83
		NL-A-	8202136	17/01/83
		DE-A,C	3222458	20/01/83
		US-A-	4419783	13/12/83
		CA-A-	1177206	06/11/84
		GB-A-	1366134	11/09/74
DE-A- 1920890	12/11/70	None		
US-A- 3519969	07/07/70	None		